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Design and Fabrication of Tractor Mounted Spray Feeder

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ABSTRACT

India is a land of agriculture which comprises of small, marginal, medium and rich farmers. Small scale farmers are very interested in manually lever operated knapsack sprayer because of its versatility, cost and design. But this sprayer has certain limitations like it cannot maintain required pressure; it leads to problem of back pain. However, this equipment can also lead to misapplication of chemicals and ineffective control of target pest which leads to loss of pesticides due to dribbling or drift during application. This phenomenon not only adds to cost of production but also cause environmental pollution and imbalance in natural echo system. A small tractor-operated hollow cone-based boom sprayer was developed to overcome said problems. The developed sprayer can be mounted on three-point linkage and can be operated by tractor PTO.

KEYWORDS: Nozzle, spray angle, sprayer pattern, Small tractor

Introduction

Farming is the backbone of Indian economy. In this agriculture sector there is a lot of field work, such as weeding, reaping, sowing etc. Apart from these operations, spraying is also an important operation to be performed by the farmer to protect the cultivated crops from insects, pests, funguses and diseases for which various insecticides, pesticides, fungicides and nutrients are sprayed on crops for protection. Farming has undergone a great evolution in last 50 years. Out of the various reasons involved for this evolution is control of various diseases on crops. In the modern agriculture, the usage of pesticides is still increasing moreover the 90% during initial days there was only hand spraying people use to do. Then slowly there has been development of various methods to spray out chemicals and dusts. Though these devices were highly efficient, there is a need to have certain changes. Chemicals are widely used for controlling disease, insects and weeds in the crops. They are able to save a crop from pest attack only when applied in time. They need to be applied on plants and soil in the form of spray, dust or mist. The application of pesticide is one of the most frequently used methods to protect crops and trees against diseases and insects in agriculture. [1, 2]

In order to reduce the harm to the environment and people the research and development of plant protecting machine focus on improving the mechanical work efficiency and the effective availability of pesticide. One of the most common forms of pesticides application, especially in conventional agriculture, is the use of mechanical sprayers. Hydraulic sprayers consist of a tank, a pump, a lance (for single nozzles) or boom, and a nozzle (or multiple nozzles). Sprayers convert a pesticide formulation, of one containing a mixture of water (or another liquid chemical carrier, such as fertilizer) and chemical, into droplets, which can be large rain-type drops or tiny almost invisible particles. This conversion is accomplished by forcing the spray mixture through a spray nozzle under pressure. The size of droplets can be altered through the use of different nozzle sizes, or by altering the pressure under which it is forced, or a combination of both. Large droplets have the advantage of being less susceptible to spray drift, but require more water per unit of land covered. Due to static electricity, small droplets are able to maximize contact with a target organism, but very still conditions are required. Sprayers are commonly used on farms to spray pesticides, herbicides, fungicides, and defoliants as a means of crop quality control.

India is set to be an agricultural based country approximately 75% of population of India is dependent on farming directly or indirectly. Our farmers are using the same methods and equipment for the ages. E.g. seed sowing, spraying, weeding etc. There is need for development of effective spraying and weeding machine for increasing the productivity. Pests, insects and diseases are disastrous to the crops since origin of agriculture. Different methods are used to control these pests and insects but most effective and reliable method to control these is chemical application. In recent decades increased use of chemicals caused hazardous condition related to environment and public health. Nowadays agriculture is facing significant challenges, due to increase in public concerns about the impacts of agricultural production practices on the environment to have a safe and secure environment for living.

So, agricultural community is forced to invest huge amount of money in the area of controlled chemical applications. Due to daily rising demand of human population, decreasing crop acreage, use of pesticide in agriculture is increasing day by day. Excessive use of chemicals results in the resistivity of the insects to the chemicals, pollutes the environment and ground water and also results in increase in the cost of crop production. In India, most of the farmers uses manually operated sprayer such as knapsack sprayer. [1, 2]

But these sprayers are inefficient, time consuming and exhausting. Using such type of sprayer operator comes in direct connect with toxic insecticides leading to health issues. In comparison to knapsack sprayer, tractor operated sprayers are more efficient. These sprayers can be operated at higher pressures and at desired forward speeds.

Mostly in India we used the old method and equipment for the agriculture. For agriculture the pesticide and water is mostly required after the some interval of time to remove the insect from the agriculture land. In old equipment only one work has been performed at a time due to which the time as well as effort required is more. The agriculture field being small, automation is such places are a difficult task also the economic condition of majority of Indian farmers is not well to do.

1.1. History

Pavan B. Wayzode, Sagar R. Umale, Rajat R.Nikam, Amol D.Khadke, Hemant carried out their work in "Design Fabrication of Agricultural sprayers, weed with cutter.

Chemicals are widely used for controlling disease, insects and weeds in the crops. They are able to save a crop from pest attack only when applied in time. The chemicals are costly. Therefore, equipment for uniform and effective application is essential. Dusters and sprayers are generally used for applying chemicals. Dusting, the simpler method of applying chemical, is best suited to portable machinery and it usually requires simple equipment. But it is less efficient than spraying, because of the low retention of the dust. In this work we have proposed equipment that is wheel and pedal operated sprayer, it is a portable device and no need of any fuel to operate, which is easy to move and sprays the pesticide by moving the wheel and also peddling the equipment. In this equipment using reciprocating pump and there is an accumulator provided for the continuous flows of liquid to create necessary pressure for the spraying action. This wheel operated pesticide spray equipment consumes less time and avoids the pesticide from coming from front of the nozzles which will in contact of the person who sprays pesticides. Weed management is one of the tedious operations in crop production. Because of labor costs, time and fully manual weeding is unfavorable. Hence effort is made to design and develop efficient Farm equipment to perform weeding without using electric power. [2]Warner examined with the idea, however had in no way produced component for manufacturing vehicle because of electricity intake, till Mercedes-Benz engines added, which used48-volt electric to run device. An electric supercharger, each time supplied through normalinventory electricaggregators, runs autonomous of the motor to which it offers its lift. However, electrical power gobbled is often better than what a introduction linegenerator (for instance alternator) of the motor can flexiblyGarret motionInc. electric turbocharger for market passenger vehicles. The tool haselectric motorbetween theturbocharger'swheels. Thepurposeofsuperchargingconsistsofincreasingtheelectricityoutput.

Mr. Prasanna Mahale, Mr. Parmeshwar Lohar, Mr. Chaitanya Kulkarni,
Mr. Laxman Kulkarni. "Design and Manufacturing of Pesticide Spraying Machine."

The spraying of pesticides and insecticides is traditionally done by farm worker carrying backpack type sprayer which requires more human effort. Giving attention to these important problems an attempt is made to develop equipment which will be beneficial to the farmer for the spraying operations. This equipment is easy to use and operate. It makes use reciprocating pump that creates the required pressure for the spraying action. This multifunction device will come in handy that can be put to use in different spraying stages of farming as per process requirement. So we have designed a pesticide spraying machine which will not only increase productivity but also will reduce the effort of the farmers. The machine will save the time of the farmer as well as efficiency in spraying. This model carries multi nozzle pesticides sprayer pump which will perform spraying at maximum rate in minimum time. Constant flow valves can be applied at nozzle to have uniform nozzle pressure. [5]

1.2. Problem Definition

The farmers who use these types conventional backpack sprayer faces many types of problems like fatigue, tiredness, pain in spiral cord and muscles etc. Following problems can take place by use of this conventional type of pump.

1.3. Common Problems

1. Heavy in weight causes difficulty in lifting manually.
2. Fatigue to the operator due to heavy weight.
3. Big size of pump cause inconvenience to the operator.
4. Poor selection and quality of equipment.
5. Due to heavy weight during spraying, operator feels very tiredness and fatigue which reduces his efficiency.

6. These problems combined with a lack of awareness and technical knowledge and inadequate maintenance and poor field use of equipment has led to

unacceptable risks to environment and human health.

1.4. Objective

1. Aim of this project is that the farmer need not carry the entire pesticide sprayer pump on his shoulders but just insert the pesticide into the drum to operate the pump and spray the pests. This makes the farmer feel comfortable, relaxed and less tiresome.
2. To reduce human efforts due to the constant pumping action for creating pressure inside the pesticide sprayer and thereby provide a suitable environment for the user reducing the fatigue load acting on the body. As discussed previously, the farmer has to continuously keep on pumping using one of his hands and spray the pests on the crops using the other hand. This at a long run is a tiresome and cumbersome job and the farmer slowly loses interest from it.
3. This project focuses on the problem of health-related issues of the farmer (operator). Majority of them don't use any precaution like face masks and hand-gloves against the hazardous chemicals and work in direct contact with it. Consequently, this harms the farmer as the spray in the conventional method directly hits the face.
4. To reduce the overall cycle time for agricultural sprayer.
5. Multi nozzles are used and hence large area of field can be spread at a faster rate.
6. Highly durable.

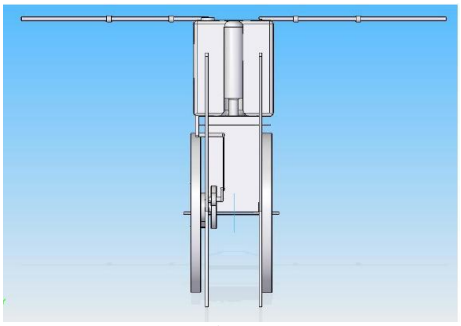
1.5. METHOLODY

Design Calculations

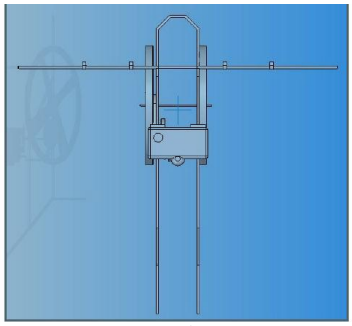
These are hydraulic energy sprayers. They utilize PTO power of the tractor to operate the pump of the sprayer. Basically the spray boom can be arranged in two ways; ground spray boom and Overhead spray boom. The overhead spray boom is designed for tall field crops and the planting is done in such a way that it leaves an unplanted strip of about 2.5 m width for operation of the tractor. Therefore a planted strip may be 18-20 m wide and after every planted strip a fallow strip has to be left for tractor operation. For ground spray boom the planting has to be done in rows keeping in view track width of the tractor. It is suitable for use when the crop is small. The sprayer essentially consists of a tank which is made of fiber glass or plastic, pump assembly's suction pipe with strainer, pressure gauges pressure regulators, air chamber, delivery pipe, spray boom fitted with nozzles. The complete sprayer is mounted on 3-point linkages of the tractor. It uses high pressure and high discharge pump as the number of nozzles may be up to 20 depending upon the crop and make of the sprayer.

Overall length (mm)	6340
Overall Width (mm)	1290
Overall Height (mm)	1570
Tank Capacity (Liter)	400
Weight (KG)	150
Field Capacity (he./day)	8 (with 14 nozzles)

On the basis of assumptions and requirements
Drive Requirements
Driving Technique: Shaft through PTO
Rotational speed of the driven and driving machine
PTO: 540 rpm
Pump: 1450 rpm Power capability Pump 2 HP
We need to find required drive center distance and shaft diameter
Design Power
Service factor, (from tables - appendix 1) for medium duty under 10hrs/day = 1.3
Design Power =1.3x1.49kw = 1.937KW
Belt Pitch
With the reference of pitch selection chart intersection of
1450 rev/min and 1.937 KW to be within the capability of



Front View of model



Top View of model

2. Construction

Basic Components of a Sprayer

1. Pump

A pump is a device used to move fluids, such as liquids or slurries, or gases from one place to another. A pump displaces a volume by physical or mechanical action. Most hydraulic sprayers are equipped with positive displacement pumps capable of developing pressure, required for many spraying jobs. The discharge capacity of these pumps is approximately proportional to the speed. A pressure relief valve or by-pass valve is required to protect these positive acting pumps from damage when the discharge line is closed and for the convenience of the operator.

2. Tank:

It is the container to hold the chemical solution. It is made up of PVC, Brass, etc. It is usually made of metal sheet or synthetic rubber or plastic having good resistant quality against corrosion, erosion, and similar actions. The size of the tank varies according to the pump capacity and the requirements.

3. Agitator:

It is the device which stirs the solution and keeps the contents in homogenous condition. Positive agitation of spray material in the tank is essential to permit using the full range of spray materials including powdery emulsions, fungicides, cold water paints or other spray material. The propeller or paddle type mechanical agitators or hydraulic agitators are very common. The agitator has large fins that quickly move from left to right. This action pushes the water out towards the edge of the tub, up the side of the drum and then back towards the center to the agitator. This process repeats, causing the chemical to rotate in tank.

4. Air chamber:

In a reciprocating type pump, an air chamber is provided on the discharge line of the pump to level out the pulsations of the pump and thus providing a constant nozzle pressure.

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5. Pressure gauge:

It is a dial gauge which indicates the pressure at which the liquid is delivered from the pump. A pressure gauge properly calibrated, within the pressure range of the pump is provided on the discharge line to guide the operator for making proper adjustment of the pressure at site. The pressure pump, in the Power sprayer, is operated by a small power unit ensuring a constant steady pressure from 20 to 55 kg/cm2.

6. Pressure Regulator:

The pressure regulator serves several important functions. It is the means of adjusting the pressure as required for any spray job within the pressure range of the pump. With the positive displacement type of pump, it also serves as a safety device in automatically unloading the excess pressure by directing the unused discharge flow from pump back to the tank.

7. Valves:

A valve is a device that regulates the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways

8. Strainer:

It is a small circular plastic ring with nylon wire mesh to filter any dust particle coming with the chemical solution. It is included in the suction line between the chemical tank and the check valves. In some sprayers strainers are provided at the mouth of the chemical tank. Strainers are very important to reduce clogging, excessive erosion of spray tips and consistent fluid circulation of your sprayer equipment. As the name eludes, this part strains or filters debris to ensure even uninterrupted flow.

9. Nozzles:

It is the component which breaks the fluid in to fine droplet. Automation of spray fluid is usually achieved by discharging the liquid through an orifice called nozzle under pressure. Atomization is also achieved by breaking up the jet of liquid with a blast of air.

3. Working

Therefore, the manually operated sprayer finds wide application in such condition. In Indian farms two types of sprays are used: Hand operated and Fuel operated pump. India is a land of agriculture which comprises of small, marginal, medium and rich farmers. Small scale farmers are very interested in manually lever operated knapsack sprayer because of its versatility, cost and design. But this sprayer has certain limitations

like it cannot maintain required pressure; it lead to problem of back pain. However this equipment can also lead to misapplication of chemicals and ineffective control of target pest which leads to loss of pesticides due to dribbling or drift during application.

This phenomenon not only adds to cost of production but also cause environmental pollution and imbalance in natural echo system. This paper suggests a model of manually operated multi nozzle pesticides sprayer pump which will perform spraying at maximum rate in minimum time. In Normal Spray pump work on electrical battery operated or using manpower to operate lever for spraying pesticides.

4. Fabrication

4.1. Parts of Sprayer Pump

1. Cut-off Valve
2. Sprocket
3. Ball Bearing

4.2. Cost Estimation

Material cost

Sr. No	**Material**	**Cost**
1	MS square pipe	6700/-
2	Nozzle	2100/-
3	Spray hose	1440/-
4	Water tank	1500/-
5	Straight MS Pipe (2)	1000/-
6	Compressor	9000/-
7	Nut bolt	1000/-
8	Hose Pipe	1200/-
9	PVC Pipe	240/-
10	Extra material	2000/-
Total Cost		**26,180/-**

Operation cost

Sr. No	Operation	**Labor and Machine cost**
1	Cutting	1430/-
2	Drilling	540/-
3	Welding	1630/-
4	Grinding	280/-
5	Painting	1800/-
Total Cost		**5,680/-**

Final cost= Material cost + Operation cost=26,180+5,680 = 28,860/-

5.Advantages

- It does not require any kind of non-renewable energy is mechanical, electrical and pressure energy.
- It reduces the fatigue of operator during the operation.
- It increases the efficiency of operator
- It can cover more area of land during spray.
- It can adjust the height of spray by using adjustable.
- Its cost is less than electrically and solar operated pump.
- It has is less air pollution.

- Labor Saving
- Time-Saving
- Accurate Delivery
- Uniform Coverage
- Chemical Saving
- Safety

6.Disadvantages

- In irregular area of land, it can difficult to operate.
- In rainy days in muddy environment it is difficult to operate.
- For irregular crops this pump is difficult to work.
- The flow is not uniform, so we have to fit a bottle at both ends.
- The flow is very less & can't be used for high flow operation.

7.Future Modification

- More number of nozzles can be used.
- A new design can be implemented to eliminate the need for pulling the machine manually.
- Stronger but light in weight materials can be used for the frame

8. Result

Spray pattern

The nozzle spray volume was collected in test tubes and evenness of the spray was determined by drawing a pattern graph for different working pressures. The bar graph of spray pattern (graph 03) for 600 kPa followed almost a normal distribution, which is a sign of uniform spray pattern and for other two pressure setting that is 500 and 700 kPa, the pattern tends to deviate from normal distribution as shown . The discharge data of individual nozzle obtained in different pressure level were stored in M.S. Excel and statistical analysis was conducted. The data were analyzed on computer using factorial CRD statistical software packages. After analyzing the data, a set of independent variable giving optimum value of pressure 600 kPa was used for field evaluation.

Spray angle

Spray angle was found to be 800, 85oand 88o for 500, 600 and 700 kPa pressure settings, respectively (graph 05). The recommended angle of hollow cone nozzle is 65o to 110o.

9.Conclusion

The suggested model has removed the problem of back pain, since there is no need to carry the tank on the backbone and solder.

1. More no. of nozzle which cover maximum area of spray in minimum time at maximum rate.
2. Proper adjustment facility in the model with respect to crop helps to avoid excessive use of pesticides which result into less pollution.
3. Imported hollow cone nozzle should be used in the field for the better performance.
4. Muscular problem is removed and there is no need to operate lever.
5. After having a trial, we have found that one finds it easy to operate push type machine.
6. It is little heavy but efficiently working in rough conditions of farm. It is economical therefore affordable for all kind of farmers.

In short while conclusion this paper we fill file quite contended in having completed the project assignment well on time we had enormous practical experience on fulfill of manufacturing schedule of working project module we are therefore happy to state the calculations of mechanical aptitude proved to be very useful purpose agriculture pesticide sprayer is designed to reduce human effort is used to agriculture field by spray pesticide now a days farmer more used pesticide in farm to get better crop. The motive behind developing this equipment is to create mechanizations which will help to minimize effort of farming. It is suitable for the spraying at minimum costs for the farmers so that; he can afford it of the many products available. Also we will reduce the operator fatigue and cover the maximum area within minimum time as compare to single sprayer.

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